12-2007

Charting the New Territory of Adaptive Co-management: A Delphi Study

Ryan Plummer
Brock University

Derek Armitage
Wilfrid Laurier University, darmitage@wlu.ca

Plummer, R., and D. R. Armitage 2007. Charting the new territory of adaptive co-management: a Delphi study. *Ecology and Society* **12**(2): 10. [online] URL: http://www.ecologyandsociety.org/vol12/iss2/art10/

Research

Charting the New Territory of Adaptive Co-management: A Delphi Study

Ryan Plummer [1] *and Derek R. Armitage* [2]

ABSTRACT. Complex systems understanding implies a world characterized by dynamic, nonlinear interactions, discontinuities, and surprises. Such conditions are not amenable to conventional resource management approaches that stress command-and-control, and therefore, novel governance approaches more suited to complexity and uncertainty are required. Adaptive co-management has emerged as an interdisciplinary response to this need, and blends the adaptive management and collaborative management narratives. However, concepts associated with adaptive co-management are relatively new and quickly expanding from multiple perspectives. The objective of this paper is to take stock of this relatively recent concept and synthesize current thinking in terms of: (1) the core components of adaptive co-management, (2) emerging research directions, (3) the barriers to implementation of adaptive co-management, and (4) criteria for success. To explore these four areas, a three-round, classical Delphi process was administered with an expert panel of 30 individuals. All members of the expert panel initially responded to open-ended questions, and the qualitative results were analyzed using QSR NVIVO. The subsequent two rounds of the Delphi required quantitative responses in which the expert panel was asked to indicate the level of importance using a seven point likert scale associated with specific items. Results of the Delphi survey reveal a high degree of consensus on several core areas within this emerging interdisciplinary governance approach. Results of this research should foster precision with respect to employment of the term, foster scholarly discourse, and indicate areas of practical importance to adaptive co-management.

Key Words: *adaptive co-management; adaptive management; collaboration; Delphi method; environmental governance.*

INTRODUCTION

Complex systems theory is offering a unique view of the world. Instead of the world viewed as near-equilibrium, complex systems theory highlights a world characterized by dynamic nonlinear relations that result in discontinuities and surprises (Levin 1999, Gunderson and Holling 2002). Ecosystem resilience, the ability of the system to absorb perturbations, thus becomes of paramount importance for sustainability (Folke et al. 2005). From this view, social and ecological systems are coupled, i.e., one complex adaptive system, and reductionism offers little hope for sustainability because predictability and control are precluded (Berkes and Folke 1998, Folke et al. 2005). This further reinforces the limitations of "command and control" approaches to resource management (Holling and Meffe 1996).

The search for innovative responses to conditions of social-ecological change and uncertainty has focused on adaptive management (Jiggins and Röling 2000). The idea of adaptive management was formulated and established by Holling (1978) and Walters (1986). An adaptive management approach views actions and policies as experiments and emphasizes the need for "learning by doing" (Walters and Holling 1990, Lee 1993, Johnson 1999). Adaptive management involves: generating alternative hypotheses, assessing the value of more information, developing models for future learning and hypotheses, formulating policy options, building criteria to facilitate option comparisons, and conducting option evaluation (Hilborn and Walters 1992). In so doing, the aim of resource managers should be to develop an integrative understanding of factors, e.g., dynamics, feedbacks, thresholds, which reduce resilience of the system (Berkes et al. 2003). Increasingly, hybrid forms of

[1]Brock University, [2]Wilfrid Laurier University

adaptive management are being articulated in which multiple actors are engaged in problem definition, risk sharing, and efforts to find resource management outcomes that contribute to the common good (Brunner et al. 2005). Conventional forms of active adaptive management, i.e., experimentation, remain, but additional emphasis is directed at the social and institutional conditions, which seek to facilitate the transfer of science into the decision-making process.

At the same time, policy directions in environmental governance clearly signal the move away from regulatory control and toward cooperative models found on collaborative relationships (Kooiman 1993, Glasbergen 1998, Ribot 2002). A rich tradition of co-management practice and research exists. Experiences with co-management are now well documented to include fisheries, forestry, agriculture, and wildlife resources. Co-management research is well established and largely traceable to works by Berkes (1989), Berkes et al. (1991), and Pinkerton (1989) who helped conceptualize the notion of co-management and advanced early middle-level theoretical propositions explaining conditions for its success. Conceptual development has also been facilitated by those examining co-management efforts in northern regions where new legislation, i.e., land claims, have required alternative decision-making models (see Feit 1988, Osherenko 1988). Advances in understanding co-management have led to refinements in associated terminology, a proposed conceptual framework of the phenomena, and critical analysis of the concept (e.g., Plummer and Fitzgibbon 2004*a*,*b*).

The assumptions and boundaries of current co-management knowledge have more recently been challenged. Co-management has been regarded as a power sharing arrangement occurring between state-based and community-based systems, but it is now evident that neither are homogenous entities (Carlsson and Berkes 2005). Just as the assumption of who is involved in co-management is being questioned, so to is the perspective of institutional theorists who have focused on the structure of co-management arrangements. Compelling arguments have been made that co-management ought to be considered a dynamic and problem solving process (Pinkerton 2003, Carlsson and Berkes 2005). De Urioste-Stone et al. (2006), have also identified the need to strengthen the capacities of co-management institutions and organizations. Co-management has been pursued with the supposition that it is beneficial because it may increase local participation in management, enhance legitimacy, and increase equity in decision making (Yandle 2003, Plummer and FitzGibbon 2004*b*). These overwhelming positive promises associated with co-management are being called into question as critical reflection from multiple perspectives on the experience is being urged (Nadasdy 2003, Natcher et al. 2005).

The manner in which academics are framing co-management is evolving in new directions. Adaptive features inherent in co-management, e.g., flexibility, dynamic process, social learning, appear to coincide with complex systems thinking, and it has therefore received increasing attention as a potential means to pursue learning by doing, as articulated in the adaptive management literature (Olsson et al. 2004, Carlsson and Berkes 2005, Folke et al. 2005, Armitage et al., *in press*). Work by Armitage (2005), Plummer (2006), and Wollenberg et al. (2007) suggests that learning has a substantive role to play in this process. Building on a strong theoretical base, recent trends to merge the principles of adaptive management and collaborative management have resulted in the concept of adaptive co-management, i.e., an approach that is distinct from either.

The term adaptive collaborative management and its synonym adaptive co-management appear to have initially materialized from the Center for International Forestry Research (CIFOR) during a project on criteria and indicators in 1997 to focus attention on the pluralistic social contexts in which adaptive management may occur (R. Prabhu 2006, *personal communication*). This initial project garnered support for the concept in Asia and Africa as well as introduced the term into the academic lexicon (Colfer et al. 2001, Ruitenbeek and Cartier 2001). As a consequence of complex systems theory greater emphasis is directed to the roles of adaptation, learning, and scenario development as tools to explore and negotiate visions of desirable states and the pathways available to foster social-ecological resilience. Somewhat independently, the term adaptive co-management has emerged more broadly to reveal a new direction of co-management scholarship, which resonates closely with the above ideas (e.g., Folke et al. 2003, Marschke and Nong 2003, Olsson et al. 2004, Folke et al. 2005, Armitage et al. *in press*).

Adaptive co-management blends the adaptive management and collaborative management narratives and represents a potential innovation in natural resource governance under conditions of change, uncertainty, and complexity. The emergence of this interdisciplinary approach, however, raises an important issue. Unlike other terms falling under this umbrella, e.g., partnership, collaboration, and co-management, the amalgam of literature associated with adaptive co-management is relatively new and quickly expanding from multiple perspectives. It is appropriate at this point, therefore, to take stock of this relatively recent concept.

This article aims to capture the current state of adaptive co-management knowledge. More specifically, this research seeks to discover how adaptive co-management is understood and conceptualized. Four objectives guide this effort: (1) to identify the core components of adaptive co-management, (2) to elucidate emerging research directions, (3) to examine the barriers to implementation of adaptive co-management, and (4) to document criteria for success. A Delphi survey methodology was used in this research to address these four objectives and is described in the second section of this paper. We organize the results of the Delphi survey in terms of the information gained from experts, the extent to which consensus among survey participants emerged, and the priority or importance assigned to each of the items/issues. Presentation of the results is structured according to the above four objectives. In depicting adaptive co-management at this early stage of development, we hope to contribute precision to the use of the term and to foster discourse, both scholarly and pragmatically, about this novel approach.

METHODS

A Delphi methodology was selected as the most appropriate means to achieve the goals and objectives of the research because it provides a way to solicit and gain consensus by experts on an emerging issue while ameliorating problematic group processes such as bias and pressure (Hasson et al. 2000, van Zolingen and Klaassen 2003, Landeta 2006). A substantial challenge for those who want to use the Delphi method is the absence of universal guidelines (Hasson et al. 2000). In synthesizing recent literature that has sought to address this void (Hasson et al. 2000, Keeney et al. 2006, Landeta 2006), the Delphi process involves:

- A group of participants who are selected because of their expertise and/or specialization in the subject matter being considered;
- A process of multiple iterations or repetitions through which the opinions of experts are discovered, consensus is achieved, and importance is determined;
- Feedback to the experts is controlled by a coordinator, which permits the experts to reflect and interact via the questionnaire instrument, limits extraneous information, and insures anonymity;
- Information generated by the experts and gained subsequently contributes to the final answer or forecast.

This method has also recently been implemented by De Urioste-Stone et al. (2006) as a mechanism to "... better understand the co-management phenomenon, especially as it refers to the identification of capacity building needs among institutions".

In determining what expertise was required to provide insight on adaptive co-management, consideration was given to the interdisciplinary nature by which individuals approach the subject, the importance of research and learned scholarship, and demonstration of knowledge and skills in practice. These requirements were made operational via three criteria: (1) the individual had to focus on co-management/adaptive co-management as opposed to adaptive management, but could do so from any number of perspectives or disciplinary orientations, e.g., common property, anthropology, natural resource sciences, etc.; (2) the individual had to contribute to scholarship on the subject as evidence by scholarly publications; and/or, (3) the individual had to have more than three years experience working in a co-management setting.

A global search was subsequently conducted to identify individuals who met these expertise requirements. This search involved a review of the co-management and adaptive co-management literature, a search of co-management initiatives via the Internet, and retrieval or electronic mail address

for individuals identified. The strength of this approach is that it provided considerable breath in terms of geographic scope and experience with various resource types; it is also consistent with the rationale outlined and approach used by De Urioste-Stone et al. (2006).

We do not presume to have generated a complete list of individuals suitable for the Delphi process. For example, an acknowledged limitation was that only those with access to electronic mail could participate. Nevertheless, this search revealed 97 individuals who met the above criteria. A letter of invitation as well as an informed consent form was sent to all 97 individuals by the Delphi coordinators. A total of 30 individuals positively responded to the invitation and constituted the expert panel for this research. Largely due to ethics and confidentiality requirements, specific characteristics of individual respondents were not collected. Additional research to relate the results of the Delphi to disciplinary and/or other respondent parameters would be interesting, but is beyond the scope of this study.

The Delphi process was structured into three rounds, the specific instrument for each round was pilot tested before being distributed to the expert panel. In the first round of the process, each member of the expert panel was asked to respond to four open ended questions and to include explanatory remarks for his or her answers. The four questions posed were:

1. What do you feel are the core components of adaptive co-management?

2. In your opinion, what are the critical themes or key questions for adaptive co-management research, e.g., new directions needed, core assumptions that require testing?

3. What are the key challenges or constraints confronting adaptive co-management in practice/application?

4. What is successful adaptive co-management?

All members of the expert panel responded to these open ended questions, and the information received was compiled according to question number into a QSR NVIVO database. QSR NVIVO is a computer program designed to assist with the management and analysis of a large amount of qualitative data. Most respondents provided at least one full typewritten page of feedback. Qualitative analysis of the data started with the process of open coding. This process involves grouping similar responses together as themes emerge and affixing labels or codes (Neuman 1994). Axial coding was subsequently undertaken in which preliminary codes were revisited and data were further categorized if necessary (Miles and Huberman 1994, Neuman 1994). It is important to note that qualitative analysis was not aimed at adding or eliminating any responses offered by the expert panel. Rather, it only sought to minimize redundancy by grouping similar ideas together (Hasson et al. 2000). Inter-researcher verification added robustness, i.e., validity, to the qualitative analysis. As an outcome of this process, extensive lists of responses from the expert panelists were developed that corresponded to each question.

The second round of the Delphi process sought to have members of the expert panel establish the importance or priority of the issues identified in round one. A questionnaire instrument was developed, which presented the responses to each of the questions posed in round one. The statements were not presented in any particular order. Members of the expert panel were asked to indicate the level of importance, and using a seven point Likert scale they would assign to each particular item. All members of the expert panel completed and returned the questionnaire. Responses were recorded in an Excel spreadsheet. The statistical package for the Social Sciences (SPSS, version 14) was used for data analysis, which involved generation of descriptive statistics for all items. A second important part of data analysis involves the movement toward consensus and the retention of items/issues in the subsequent round. No clear or universal guidelines exist in the literature for retention criteria (see van Zolingen and Klaassen 2003, Keeny et al. 2006). Given the goals of this particular study, items, e.g., statements/questions, for which 75% of the expert panelists ranked as being important to most important, i.e., ≥ 4 on the Likert scale, were retained.

The third round of the Delphi process sought to move toward consensus on the importance of each of the items. In the final round, members of the expert panel were asked to evaluate the level of importance that he/she assigned to each item in round two, reflect upon the importance, i.e., examine the mean value and standard deviation assigned by the collective expert panel, and decide

if he/she would like to retain his/her original response or adjust it. A response rate of 96.7% was gained from the expert panel in returning the round three questionnaires. In addition to the data compilation and analysis measures undertaken in the proceeding round, a Wilcoxon procedure was used to examine inter-round differences, consistent with the work of De Urioste-Stone et al. (2006).

Following the completion of the study, the results of the classical Delphi were presented at a workshop on adaptive co-management. The resulting dialogue at the workshop enriched interpretation and understanding of the outcomes of the Delphi process, and is therefore, reflected upon in the results section where appropriate. The idea of removing the element of anonymity, i.e., original participants in the classical Delphi process remained anonymous, and having participants discuss points of consensus and deviation is consistent with the spirit of a group/workshop Delphi (see Webler et al. 1991, van Zolingen and Klaassen 2003).

RESULTS

The results of the classical Delphi study are presented below and are organized according to the four main objectives. The outcomes from each round of the classical Delphi process are described, and the salient findings are highlighted.

Core components of adaptive co-management

A wealth of information was received in the first round of the Delphi process regarding the core components of adaptive co-management. Open-ended responses ranged from a few bullet points to more than one half of a page of detailed commentary, which often combined a number of specific workings. The following quotations are illustrative of the responses received.

[From] my prior understandings and experience, I would think it would encompass core components of (1) shared (not necessarily evenly) management authority; (2) inclusion of stakeholders (broadly defined to include governments not just 'users,' and changeable so that specific identities vary among institutional examples); (3) joint decision-making: again, specific management functions that are jointly managed will vary and joint does not necessarily imply equality; (4) structured, e.g., experimental, management actions; (5) information collection that allows for double-loop learning by co-managers; 6) adaptive institutional capacity, that is the ability to evolve and change in response to new information (Expert 14).

Core components of co-management: "shared" regulation of resource users/harvesters, i.e., we manage/regulate the users and not the resource, by both the users themselves and more formal governmental authority; it should empower rather than disempower resource users and should employ the knowledge base of both the resource users and the regulators. Core components of "adaptive:" a commitment to learning by doing; a commitment to explicit experimentation; the existence of feedback loops that can be used, i.e., the necessary knowledge/science base; the legal/institutional ability of managers to make decisions and change behavior in light of the feedback (Expert 80).

During the first round of open coding, 36 different themes emerged from the data. The magnitude of these themes varied considerably, as some had considerable strength, i.e., as many as 20 paragraphs, and others were only identified by one respondent. It is important to note that the qualitative analysis of responses was not aimed at eliminating any responses offered by the expert panel. Rather, it only sought to minimize redundancy by grouping similar ideas together. In the second round of axial coding, the researchers revisited the preliminary concepts and were able to further reduce them into 30 themes, as shown in Table 1.

In round two, members of the expert panel were asked to assign a level of importance to each of the 30 core components identified using a seven point Likert scale. Results of the second round are shown in Table 1. As per the retention rule outlined above, only items that 75% of the expert panelists ranked as being important to most important, i.e., ≥4 on the Likert scale, were retained. The results of the third and final round of the Delphi process in which members of the expert panel considered feedback and either retained or modified their answers are also shown in Table 1. All items presented in this third round were considered by the expert panel to be important, as at least 75% of the respondents ranked them ≥ 4 on the Likert scale. The Wilcoxon procedure revealed no significant differences between round two and round three, which reinforces that consensus was reached.

The five core components of adaptive co-management assigned the greatest level of importance, i.e., mean value, by the expert panel in descending order were:

- adaptive capacity to evolve and change in light of feedback;
- social learning by which actions are developed, tested, reflected upon, and revised, i.e., double loop learning, learning by doing;
- communication, i.e., sharing of information and establishment of shared understanding;
- sharing authority, i.e., power, between at least two groups of actors, usually, but not limited to, the state and civic actors and/or users; and
- shared decision making.

In the subsequent workshop, individuals specifically discussed the above items to which the expert panel had assigned the greatest level of importance. This discussion verified the high importance assigned to these items and offered further insight. For example, in considering the item of sharing authority, i.e., power, it was noted that multiple sources of knowledge and culture should be engaged, more emphasis should be explicitly placed on power, and both multiple levels of organizations and users require attention. Social capital and values/vision were core concepts identified which individuals at the workshop felt should be assigned greater importance. Much discussion was focused on the need to better understand the meaning of the core concepts as well as their relationship to practice.

Critical themes or key questions for adaptive co-management research

The greatest volume of open ended responses in round one of the Delphi process came from the expert panel in response to identifying critical themes or key questions for adaptive co-management research, in which respondents were encouraged to highlight new directions or core assumptions that required further testing. Most respondents from the expert panel identified multiple themes or questions as well as extensive commentary of at least one-half page to support their choices. A few quotations without the extensive supporting narrative from respondents illustrate the general form of the responses.

Whether these adaptive co-management (ACM) systems actually are more effective. I am convinced that: (1) coupled systems are more sustainable than decoupled systems; (2) systems left alone, "permitting emergent behavior" in a complex world are more sustainable than systems that are "directly managed using introduced models" (Expert 47).

I think we need to consider "power" more effectively to understand the learning process, e.g., how do we listen to marginalized others, and the process of co- in the co-management equation (Expert 83).

Open coding the extensive amount of information revealed 47 themes, but the magnitude of themes was considerably less, i.e., no item was discussed in more than 10 passages. The second round of axial coding reduced the total number to 40, as shown in Table 2. Results of round two, in which the experts assigned importance to each item, are presented in Table 2. Not surprisingly, in light of the relative weakness around each of the themes, many items were not retained in the subsequent round. Members therefore had a shorter list of items to consider in the final round, the results of which are also provided in Table 2. Consensus was reached by members of the expert panel that all items in third round were important. The Wilcoxon procedure verified that there were no significant differences between items in the second and third rounds.

A number of specific research questions emerged that were assigned a high level of importance. What role do institutional arrangements play in enabling or impeding ACM? How does ACM work along horizontal linkages and across vertical scales? How are multiple sources/types of knowledge integrated and used? Does ACM enhance the well-being or livelihoods of communities? Do ACM systems result in better management than alternative approaches? How do we expand lessons learnt from specific sites or sectors to undertake an ecosystem or regional-scale approach?

Dialogue about these themes at the subsequent workshop was fruitful as it expanded the items above in greater detail. Institutional arrangements, for example, were expanded to more fully encompass a range of issues, e.g., conflict resolution, monitoring, as well as decentralization.

It also brought forward a number of items, often worded slightly differently, that were identified by the expert panel, which individuals at the workshop felt should receive greater recognition. Are we able to collectively define terms? Do we have a shared understanding of ACM? What role does leadership play in enabling or impeding ACM? What is the role of infrastructure/technology? How can we adapt methodologies from other fields? In addition to recognizing the importance of existing items, e.g., culture, conflict, power, risk, discussion at the workshop also directed attention to how innovation and experimentation could be stimulated, the possibilities of transformation, and the issue of creativity.

Key challenges or constraints confronting adaptive co-management in practice/ application

Information gained from the expert panel revealed numerous challenges or constraints to implementing adaptive co-management in practice. A total of 35 themes emerged from the first round of open coding; the magnitudes of these themes were diffuse with each being constituted by a few paragraphs. The following responses are illustrative of the structure used in which a key challenge or constraint was identified and elaborated upon in an accompanying rationale or explanation.

Policy and regulatory frameworks: In most developing countries the state is still a paternalistic institution and command and control pathologies are still quite widespread. This inhibits the space for ACM to develop. This is particularly true with respect to process of self-organization and information exchange (Expert 98).

History: lack of understanding of sociocultural, economic, political, and geographic relationships and the general "way things are done around here" (Expert 69).

Maintaining collaborators' commitment to the process of: (a) seeing an intervention through the planned period of application so results can be evaluated and (b) committing the time and resources needed to perform credible application (Expert 45).

Subsequent axial coding reduced the number of themes to 31, as presented in Table 3. Results from the second round concerning key challenges or constraints are detailed in Table 3. Although consensus was almost unanimous about the importance of some items, e.g., unwillingness and inflexibility of the state and resource managers to share power, 13 items were not retained because less than 75% of the expert panel did not view them as being important. In round three, the expert panel was asked to consider feedback on the remaining 18 items and again assign importance to each using a Likert scale. Complete results for the round three are shown in Table 3.

Consensus was reached by the expert panel in the third round, as all remaining items were regarded as being important. The Wilcoxon procedure did not indicate a statistically significant difference between the means for any items in rounds two and three. According to the expert panel, the key challenges or barriers to ACM in practice with the greatest importance include:

- the unwillingness and inflexibility of the state and resource managers to share power; power asymmetries among those involved;
- insufficient commitment of resources, e.g., financial, human, technical, etc;
- group dynamics: preconceived attitudes about stakeholders unresolved conflicts and defensiveness, mistrust, domination of particular interests; and
- lack of capacity and information asymmetries.

Dialogue at the workshop about these results provided an array of reactions. The importance assigned to most of these items were verified, whereas the item "insufficient commitment of resources," e.g., financial, human, technical, etc., was viewed to be more appropriately combined with the item of capacity. The item "lack of capacity and information asymmetries" received considerable debate, noting the importance of context and the need to connect it to power asymmetries. The individuals at the workshop highlighted the importance of "lack of incentives or reward structures for collaboration and experimentation" and the pragmatic challenges associated with an inability to maintain continuity and institutional memory.

Successful adaptive co-management

Open-ended responses to the fourth question by the expert panel were the most concise of the four questions. Most respondents provided about a paragraph of information on what constituted successful adaptive co-management. The following examples illustrate the nature of these open-ended responses.

This is an easy question. Any management is successful if it nurtures a system that is resilient to a wide range of exogenous shocks or internal failures (Expert 47).

Managing in a way that actions are increasingly effective in meeting agreed upon goals of the managed place, based on continually improved understanding of the place (Expert 36).

A total of 21 themes emerged in the initial pass of open coding; the magnitude of these themes was diffuse with 10 passages being the greatest number. Preliminary codes were revisited but further merging was not possible and so 21 themes resulted from the first round of analysis, as presented in Table 4. Members of the expert panel assigned importance to each of the 21 items in round two; results for each of the items are presented Table 4. In following the retention rule, all but two items were preserved. After reflecting upon the round two responses, i.e., mean and standard deviations, a consensus emerged in round three about what constitutes successful adaptive co-management as at least 75% of expert panel members assigned importance to all of the remaining items. The Wilcoxon procedure did not reveal any statistically significant differences between the second and third round responses.

According to the expert panel, items assigned the greatest importance in constituting successful adaptive co-management included:

- robustness to solve/overcome challenges, e. g., ecological, economic, legal;
- evaluation/monitoring of management actions through reflection aimed at learning and making subsequent modifications;
- conservation/sustainable resource use and ecosystem health;
- a process in which stakeholders and government develop, implement, learn, and make adjustments in pursuit of a more resilient socioecological system;
- empowering the actors involved, fostering ecological and social justice, and achieving credible sustainability objectives, e.g., poverty alleviation, future options; and
- inclusion and effective participation in the process.

Individuals at the workshop tended to discuss the results of the classical Delphi regarding notions of success in a holistic fashion and focused on the entire suite of items. The need to consider the resilience of a social-ecological system as a better measure of ACM was brought forward. Diversity and inclusion were emphasized to adequately capture the complexities and varied processes that constitute ACM. The need for items to be measurable and the possibility for following-up with the formation of indicators were also raised.

DISCUSSION

This research sought to synthesize the state of adaptive co-management knowledge and to chart its future directions. A classic Delphi methodology was used to seek answers to the aforementioned questions. The expert panel consisted of 30 researchers and practitioners from around the world. Members of the panel interacted through three rounds in which they were asked to provide open ended answers to each of the four questions, complete a questionnaire assigning importance to each of the items they identified, and reconsider their responses in light of feedback. By the completion of the third round, consensus had emerged for each of the four questions, as at least 75% of the expert panel considered all remaining items to be important. Further enrichment of the results of the classical Delphi occurred through discussions at a workshop on adaptive co-management (ACM). Although the overarching intent of the Delphi study is to report information generated by the expert panel, we offer some reflections upon the results and their implications.

Adaptive co-management connects the two important narratives of adaptive management and collaborative management in the search for novel

approaches to address complexity and uncertainty. Critical questions are being asked of co-management researchers and practitioners. As a result, the manner in which co-management is being framed is evolving in new directions that stress the importance of learning and linking. Although these ideas are starting to be advanced and examined in the literature, for example using the terminology of ACM, many important questions have also emerged. What are the core components of ACM? What are the critical themes or key questions for ACM? What are the key challenges or constraints confronting ACM in practice/application? What is successful ACM?

At a broad level, the outcomes of this process provide resource managers, researchers, and community organizations with a compelling synthesis of key ideas and issues to consider when responding to social-ecological complexity. Results that identify core components and conditions for success, in particular, offer a productive foundation for the development of more adaptive and collaborative forms of resource management. Importantly, the core components of ACM assigned the greatest importance. e.g., adaptive nature, learning, communication, sharing of power, shared decision making, by the expert panel resonate strongly with the emerging literature on ACM (e.g., Ruitenbeek and Cartier 2001, Marschke and Nong 2003, Olsson et al. 2004, Folke et al. 2005, Armitage et al., *in press*).

A number of other interesting insights can be identified. For instance, power emerged as a particular point of contention in the results of the Delphi process as it was identified as an important core concept as well as a key challenge or constraint in practice. This confirms the tension in the ACM literature where the sharing of power across scales is recognized as a hallmark (e.g., Folke et al., 2005) as well as being an issue under scrutiny (e.g., Fennell et al. *in press*, Nadasday, *in press*). A countercurrent to reductionism and disciplinarity was also detected, i.e., the need to take a holistic perspective when considering success related to ACM was clear in the results of the Delphi and was reinforced by participants at the workshop. Also recognized throughout this process was the understanding that on-the-ground examples of successful ACM are still being pursued. Moreover, in those cases where principles of learning and collaboration are emphasized, that emphasis is characterized by significant variability in terms of intentionality and formality.

It is also interesting to consider concepts that did not emerge to an appreciable extent from the Delphi process. Uncertainty, experimentation, and modeling are central ideas to adaptive management and resilience theory. Although it is difficult to know why something did not emerge, we speculate that less emphasis was placed on these ideas because of the criteria used for the inclusion of experts, which required that individuals must focus on co-management or ACM. In particular, experimentation and modeling are possibly viewed as techniques to be used, or not, depending on the context in which ACM may take place. The results largely indicate a perception that techniques or tools, and more data generally, are less essential than the development of a legitimate process based on power sharing in which multiple actors are engaged in collaborative efforts to learn from experience. This corresponds, finally, with a strong tendency also exhibited by respondents to emphasize institutions. We anticipate that the results may change if the criteria for inclusion of experts were altered and/or if participation was limited to a single disciplinary perspective.

In stepping back from the specific results, we delineate the following series of crosscutting themes to inform the literature, elucidate practice, and help to chart a course for further research. Central themes include:

- Measuring outcomes of ACM: Throughout all rounds of the Delphi process responses consistently focused on the potential for ACM to result in improved ecosystem health, sustainable resource use, increased capacity/ enhanced resilience, ability to respond to risk/ uncertainty, betterment of livelihoods, and more equitable distribution of resources. Further work to develop monitoring and evaluation systems may be a particularly important feature of ongoing inquiry. Monitoring and evaluation, which is participatory and provides feedback that fosters social learning is an additional subtheme.

- Institutional arrangements: Emerging from the results of the Delphi process is the need to consider ACM as a distinctly different type of institution in which power is shared. This

theme also directs attention to the possibility for institutional novelty involving flexibility, facilitation, experimentation, and provision of incentives. An enduring question regards the effectiveness, i.e., cost and viability, of such institutions.

- Dealing with disparities: Difference emerges as a consistent theme throughout the results. Power imbalances are central and broadly concerned with how authority is shared among groups and across levels. Empowerment of those involved, especially of marginalized peoples, is fundamental to fostering ecological and social justice. Other asymmetries that constitute this theme include knowledge and culture.

- Forging connections to improve policy and practice: At a site scale, results of the Delphi process indicate attention must be directed at horizontal connections among relevant stakeholders, as well as vertically to multiple levels. Connections are also required across scales from both directions, i.e., scaling up and scaling down, in regards to policies and nested ecological systems.

- Understanding group processes for social learning: As a general theme, understanding group processes encompasses the need to engage participants and understand the social processes involved in ACM. Subthemes that consistently emerged focus on factors that shape and influence opportunities for transformative social learning: decision making, conflict, leadership, communication, knowledge systems/worldviews, trust, and group dynamics.

CONCLUSIONS

The crosscutting themes illustrate that adaptive co-management (ACM) does not consist of discrete elements that can easily be deconstructed, examined and re-assembled. ACM is an intricately woven and highly nuanced concept that is difficult to dissect. In pursuing these themes within this emerging interdisciplinary approach a clear need exists to develop a common conceptual and terminological basis. Although considerable advances have been made in understanding co-management using a variety of schemes, e.g., modeling, propositional, analytical, meta-theoretical, the need to pursue foundational theories that are simple or elegant remain an important challenge for ACM (see Plummer and Fennell, *in press*).

Building an understanding of ACM is further complicated by the simultaneous calls for implementation and accountability. Concerted efforts are therefore required to develop novel, but methodologically consistent, strategies to pursue research across geographical locations and resource contexts. The results of the Delphi study provide a platform, agreed upon by experts in this emerging topic, upon which ACM scholarship may develop. The crosscutting themes provide additional opportunities to develop propositions for further inquiry into the “promises and pitfalls” (sensu McLain and Lee 1996) of ACM.

LITERATURE CITED

Armitage, D. 2005. Adaptive capacity and community-based natural resource management. *Environmental Management* **35**(6):703-715.

Armitage, D., F. Berkes, and N. Doubleday. editors. *In press. Adaptive co-management: collaboration, learning and multi-level governance.* UBC Press, Vancouver, British Columbia, Canada.

Berkes, F., editor. 1989. *Common property resources: ecology and community-based sustainable development.* Belhaven Press, London, UK.

Berkes, F., and C. Folke. editors. 1998. *Linking social and ecological systems.* Cambridge University Press, Cambridge, UK.

Berkes, F., J. Colding, and C. Folke. 2003. Introduction. Pages 1-30 *in* F. Berkes, J. Colding, and C. Folke, editors. *Navigating social-ecological systems: building resilience for complexity and change.* Cambridge University Press, Cambridge, UK.

Berkes, F., P. J. George, and R. J. Preston. 1991. The evolution of theory and practice of the joint administration of living resources. *Alternatives* **18** (2):12-18.

Brunner, R., T. Steelman, L. Coe-Juell, C.

Cromley, C. Edwards, and D. Tucker. 2005. *Adaptive governance: integrating science, policy and decision making.* Columbia University Press, New York, New York, USA.

Carlsson, L., and F. Berkes. 2005. Co-management: concepts and methodological implications. *Journal of Environmental Management* **75**:65-76.

Colfer, C., R. Prabhu, L. Wollenberg, C. McDougall, D. Edmunds, and G. Kowero. 2001. Towards social criteria and indicators for protected areas: one cut on adaptive co-management. Pages 293-311 *in* L. Buck, C. C. Geisler, J. Schelhas, and E. Wollenberg, editors. *Biological diversity: building interests through adaptive collaborative management.* CRC Press, Boca Raton, Florida, USA.

De Urioste-Stone, S., W. J. McLaughlin, and N. Sanyal. 2006. Using the Delphi technique to identify topics for a protected area co-management capacity building program. *International Journal of Rural Management.* **2**(2):191-211.

Feit, H. 1988. *Self-management and state-management: forms of knowing and managing northern wildlife.* Pages 72-91 *in* M. Freeman and L. Carbyn, editors. *Traditional knowledge and renewable resource management in northern regions.* Boreal Institute for Northern Studies and The International Union for the Conservation of Nature and Natural Resources, Edmonton Alberta, Canada.

Fennell, D., R. Plummer, and M. Marschke. *In press.* Is adaptive co-management ethical? *Journal of Environmental Management.*

Folke, C., J. Colding, and F. Berkes. 2003. *Synthesis: building resilience and adaptive capacity in socio-ecological systems.* Pages 352-387 *in* F. Berkes, J. Colding, and C. Folke, editors. *Navigating social-ecological systems: building resilience for complexity and change.* Cambridge University Press, Cambridge, UK.

Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *The Annual Review of Environment and Resources* **30**:8.1:8.33.

Glasbergen, P. 1998. *The question of environmental governance.* Pages 1-20 *in* P. Glasbergen, editor. *Co-operative environmental governance* Kluwer Academic Press, Dordrecht, The Netherlands.

Gunderson, L., and C. S. Holling, editors. 2002. *Panarchy: understanding transformations in human and natural systems.* Island Press, Washington, D. C., USA.

Hasson, F., S. Keeney, and H. P. McKenna. 2000. Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing* **32** (4):1008-1015.

Hilborn, R., and C. Walters. 1992. *Quantitative fisheries stock assessment: choice, dynamics and uncertainty.* Chapman and Hall, New York, New York, USA.

Holling, C. S. editor. 1978. *Adaptive environmental assessment and management.* John Wiley, New York, New York, USA.

Holling, C. S., and G. K. Meffe. 1996. Command and control and the pathology of natural resource management. *Conservation Biology* **10**(2):328-337.

Jiggins, J., and R. Rölling. 2000. Adaptive management: potential and limitations for ecological governance. *International Journal of Agricultural Resources, Governance, and Ecology* **1**(1):28-42.

Johnson, B. L. 1999. Introduction to the special feature: adaptive management scientifically sound, socially challenged. *Ecology and Society*, **3**(1) 10. [online] URL: http://www.consecol.org/vol3/iss1/art10/ .

Keeny, S., F. Hasson, and H. P. McKenna. 2006. Consulting the oracle: ten lessons from using the Delphi technique in nursing research. *Journal of Advanced Nursing* **53**(2):205-212.

Kooiman, J. editor. 1993. *Modern governance, new government-society interactions.* Sage, London, UK.

Landeta, J. 2006. Current validity of the Delphi method in social sciences. *Technological Forecasting and Social Change* **73**:467-482.

Lee, K. N. 1993. *Compass and gyroscope: integrating science and politics for the environment.*

Island Press, Washington, D.C., USA.

Levin, S. 1999. *Fragile dominion: complexity and the commons.* Perseus, Reading, Massachusetts, USA.

Marschke, M., and K. Nong. 2003. Adaptive co-management: lessons from coastal Cambodia. *Canadian Journal of Development Studies* **24** (3):369-383.

McLain, R., and R. G. Lee. 1996. Adaptive management: promises and pitfalls. *Environmental Management*. **20**(4):437-448.

Miles, M. B., and A. M. Huberman. 1994. *Qualitative data analysis.* Second edition. Sage, Thousand Oaks, California, USA.

Nadasdy, P. 2003. *Hunters and bureaucrats: power, knowledge, and aboriginal-state relations in the southwest Yukon.* University of British Columbia Press, Vancouver, British Columbia, Canada.

Nadasdy, P. *In press.* Adaptive co-management and the gospel of resilience. *In* D. Armitage, F. Berkes, and N. Doubleday, editors. *Adaptive co-management: collaboration, learning and multi-level governance.* UBC Press, Vancouver, British Columbia, Canada.

Natcher, D. C., S. Davis, and C. G. Hickey. 2005. Co-management: managing relationships, not resources. *Human Organization* **64**(3):240-250.

Neuman, L. 1994. *Social research methods.* Second edition. Allyn and Bacon, Boston, Massachusetts, USA.

Olsson, P., C. Folke, and F. Berkes. 2004. Adaptive comanagement for building resilience in social-ecological systems. *Environmental Management* **34** (1):75-90.

Osherenko, G. 1988. *Sharing power with native users: co-management regimes for native wildlife.* CARC Policy Paper Number 5, Canadian Arctic Resources Committee, Ottawa, Ontario, Canada.

Pinkerton, E. 1989. *Attaining better fisheries management through co-management: prospects, problems and propositions.* Pages 3-33 *in* E. Pinkerton editor. *Co-operative management of local fisheries: new directions in improved management and community development.* UBC Press, Vancouver, British Columbia, Canada.

Pinkerton, E. 2003. Toward specificity in complexity: understanding co-management from a social science perspective. Pages 61-77 *in* D. C. Wilson, J. R. Nielson, and P. Degnbol, editors. *The fisheries co-management experience: accomplishments, challenges and prospects.* Kluwer Academic, Dordrecht, The Netherlands.

Plummer, R. 2006. Sharing the management of a river corridor: a case study of the co-management process. *Society and Natural Resources* **19**:1-13.

Plummer, R., and D. Fennell. *In press.* Exploring co-management theory: prospects for sociobiology and reciprocal altruism. *Journal of Environmental Management.*

Plummer, R., and J. FitzGibbon. 2004*a.* Co-management of natural resources: a proposed framework. *Environmental Management* **33** (6):876-885.

Plummer, R., and J. FitzGibbon. 2004*b.* Some observations on the terminology in co-operative environmental management. *Journal of Environmental Management* **70**(1):63-72.

Ribot, J. C. 2002. *Democratic decentralization of natural resources.* World Resources Institute, Washington, D.C., USA.

Ruitenbeek, J., and C. Cartier. 2001. *The invisible wand: adaptive co-management as an emergent strategy in complex bio-economic systems.* Occasional Paper Number 34. Center for International Forestry Research, Bogor, Indonesia. Available online at: http://www.cifor.cgiar.org/Publications/Papers/OccasionalPapers.htm?%09%09%09&page=%09%09%092.

van Zolingen, S. J., and C. A. Klaassen. 2003. Selection process in a Delphi study about key qualifications in senior secondary vocational education. *Technological Forecasting and Social Change* **70**:317-340.

Walters, C. 1986. *Adaptive management of renewable resources*. Macmillan, New York, New York, USA.

Walters, C. J., and C. S. Holling. 1990. Large-scale

management experiments and learning by doing. *Ecology* **71**(6):2060-2068.

Webler, T., D. Levine, H. Rakel., and O. Renn. 1991. A novel approach to reducing uncertainty: the group Delphi. *Technological Forecasting and Social Change* **39**:253-263.

Wollenberg, E., G. Limberg, R., Iwan, M., Moeliano, M., Sudana, and S. Rhee. 2007. Facilitating cooperation during times of chaos: spontaneous orders and muddling through in Malinau District, Indonesia. *Ecology and Society* **12**(1) 3. [online] URL: http://www.ecologyandsociety.org/vol12/iss1/art3/.

Yandle, T. 2003. The challenge of building successful stakeholder organizations: New Zealand's experience in developing a fisheries co-management regime. *Marine Policy* **27**:179-192.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol12/iss2/art10/responses/

Acknowledgments:

The authors wish to express their gratitude to the 30 individuals who constituted the expert panel for this Delphi study. We are particularly grateful for their sustained commitment demonstrated throughout the duration of this project. Without the considerable amount of time and knowledge generously given by these individuals this research would not have been possible. We also gratefully acknowledge the constructive and thoughtful insights on the results of the Delphi offered by the participants at the adaptive co-management workshop. This research was made possible by a Research Development Initiative (RDI) grant from the Social Sciences and Humanities Research Council of Canada.